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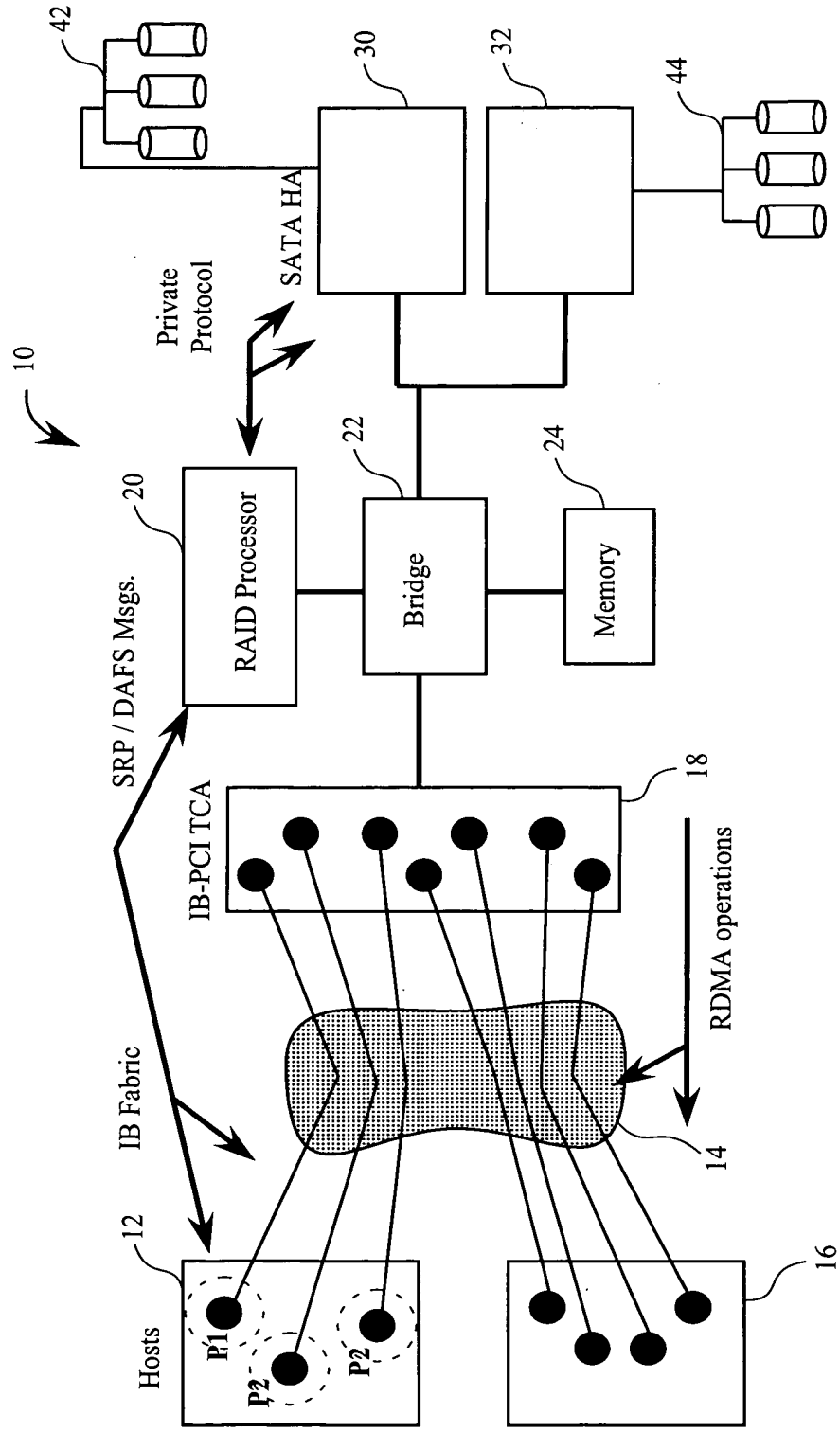

FIG. 1 (Prior Art)

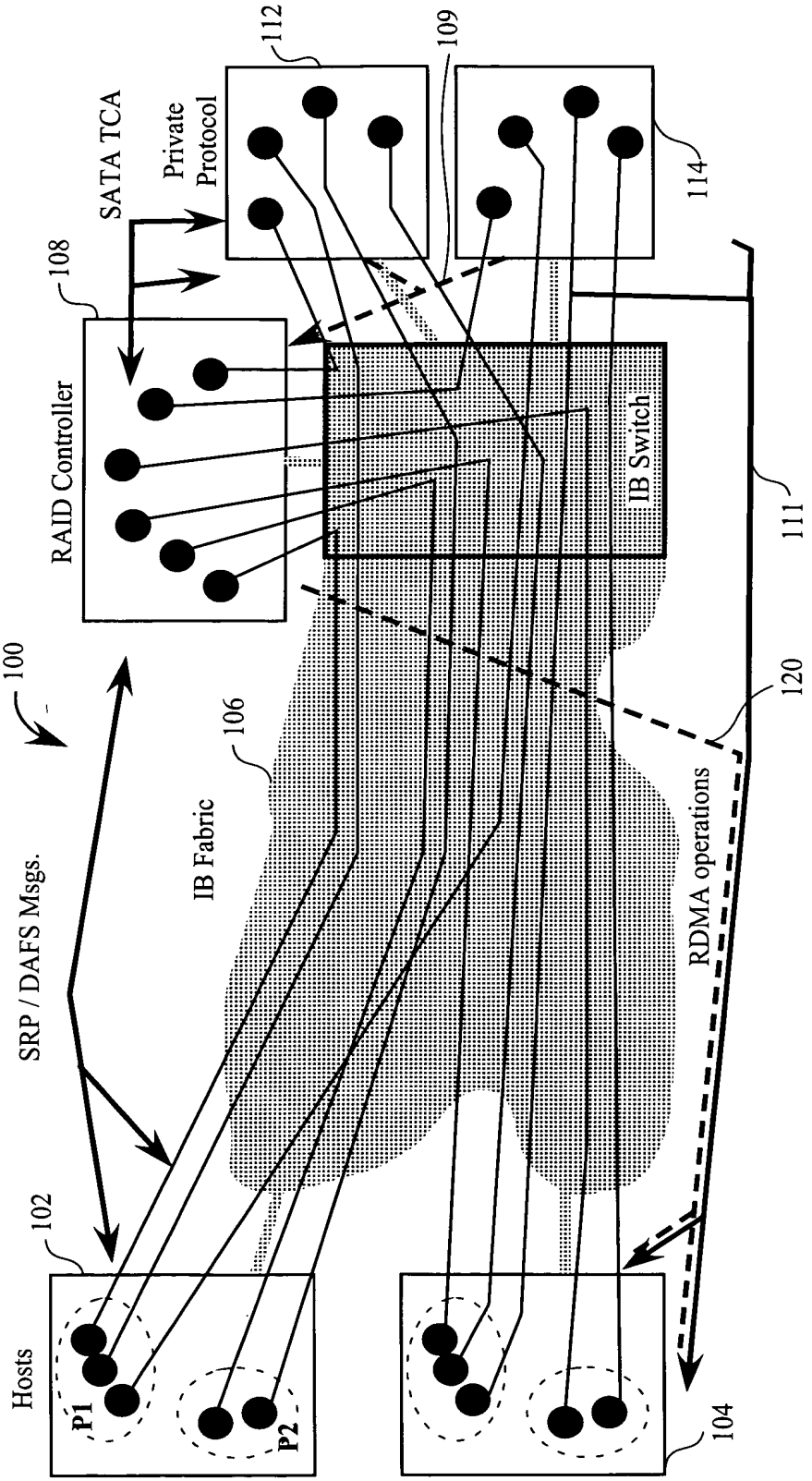
112
109
SATA TCA
Private Protocol
114
108
RAID Controller
IB Switch
111
100
106
120
IB Fabric
RDMA operations
SRP / DAFS Msgs.
102
Hosts
P1
P2
104

FIG. 2

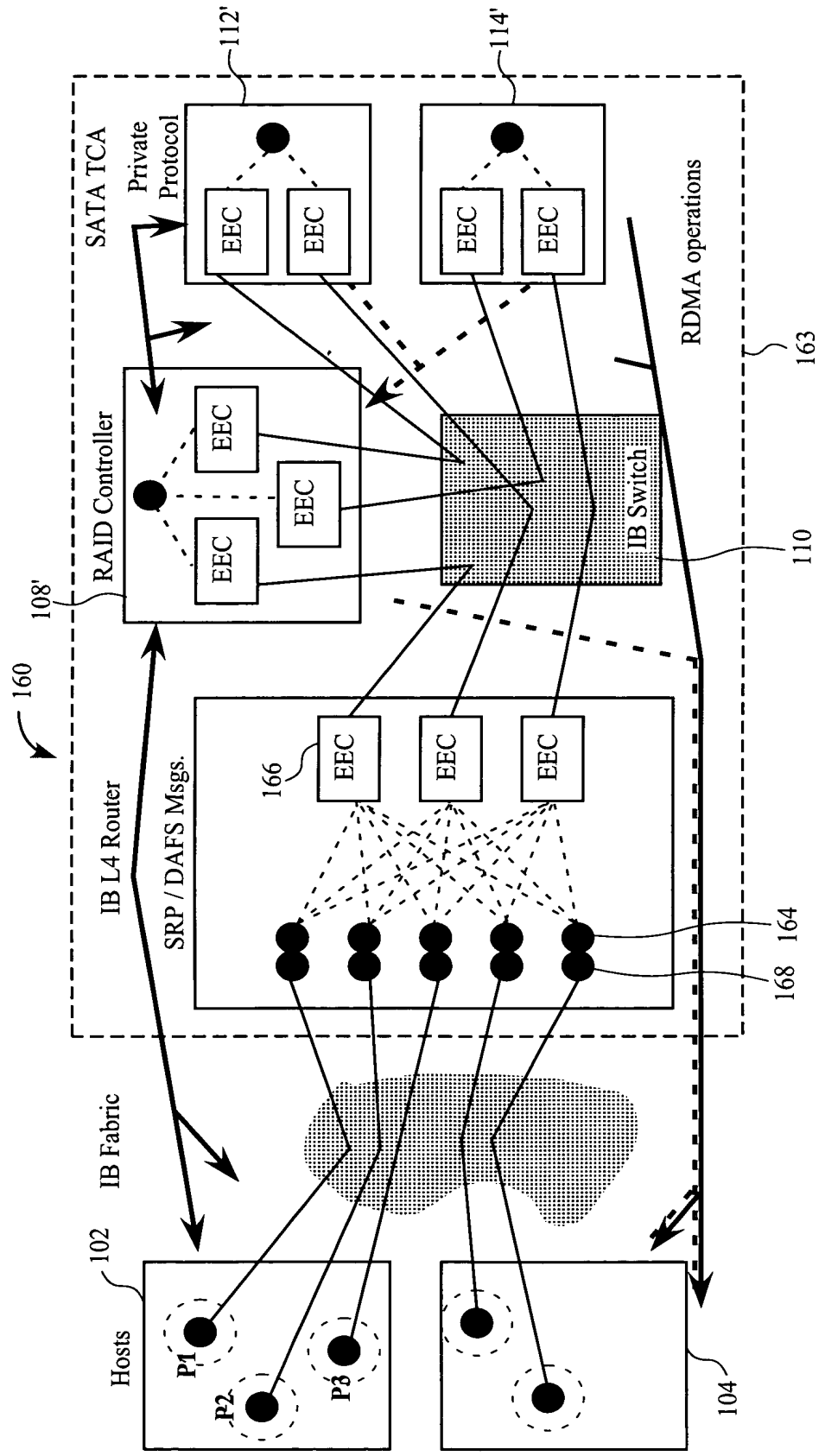
160
SATA TCA
Private Protocol
112'
114'
EEC
RAID Controller
108'
IB Switch
110
RDMA operations
163
IB L4 Router
SRP / DAFS Msgs.
166
164
168
IB Fabric
102
Hosts
P1
P2
P3
104

FIG. 3

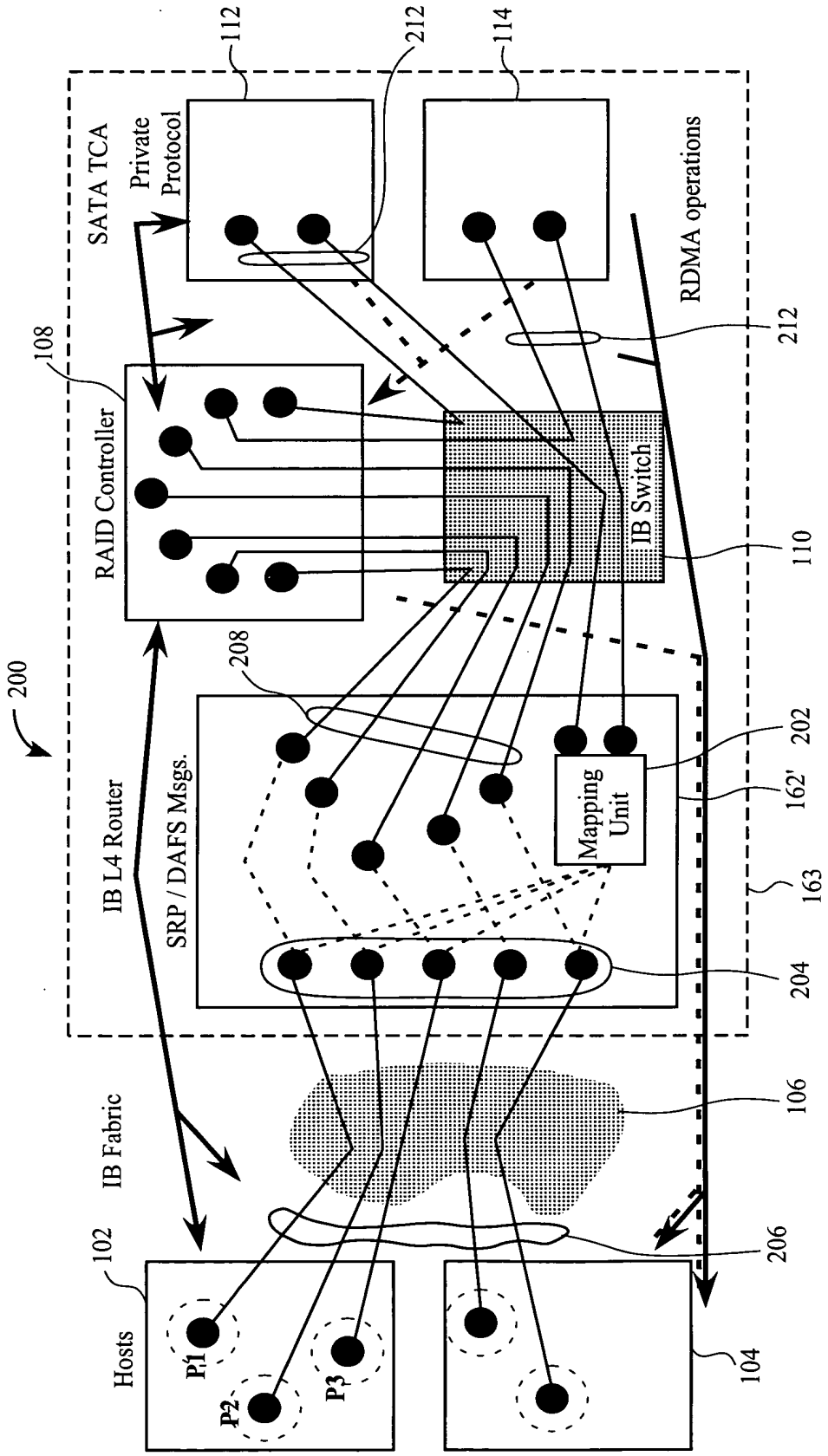
200
112
212
114
SATA TCA
Private Protocol
RDMA operations
108
RAID Controller
IB Switch
110
208
IB L4 Router
SRP / DAFS Msgs.
Mapping Unit
202
162'
163
204
106
IB Fabric
206
102
Hosts
P1
P2
P3
104

FIG. 4

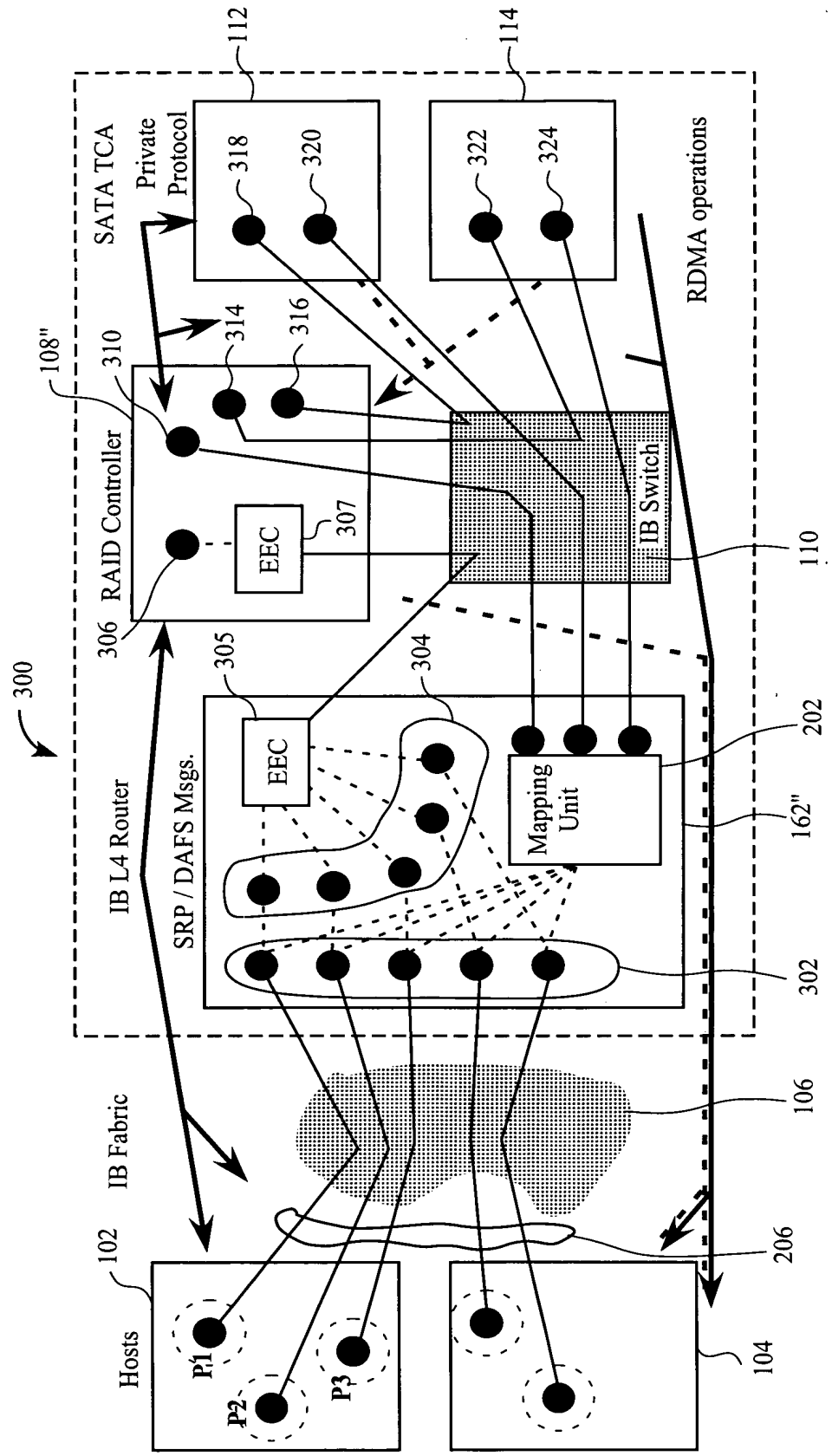
300
108"
SATA TCA
Private Protocol
112
114
318
320
322
324
RDMA operations
314
316
310
RAID Controller
EEC
307
306
IB Switch
110
305
304
EEC
SRP / DAFS Msgs.
IB L4 Router
Mapping Unit
202
162"
302
106
IB Fabric
102
Hosts
P1
P2
P3
206
104

FIG. 5

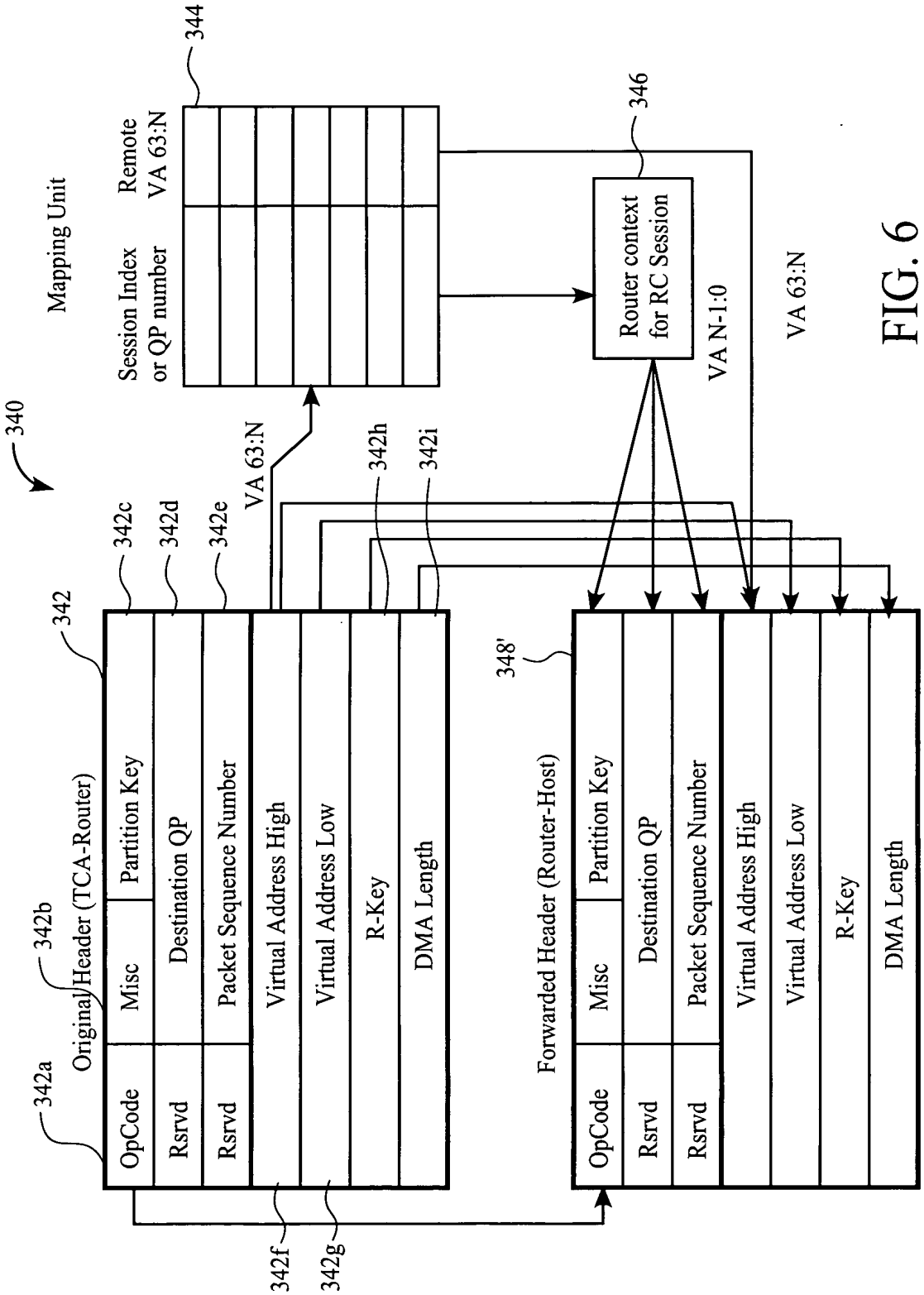
340
Mapping Unit
Session Index or QP number
Remote VA 63:N
344
346
Router context for RC Session
VA N-1:0
VA 63:N
342
342a
342b
342c
342d
342e
342h
342i
342f
342g
Original Header (TCA-Router)
OpCode
Rsrvd
Rsrvd
Misc
Partition Key
Destination QP
Packet Sequence Number
Virtual Address High
Virtual Address Low
R-Key
DMA Length
348'
Forwarded Header (Router-Host)
OpCode
Rsrvd
Rsrvd
Misc
Partition Key
Destination QP
Packet Sequence Number
Virtual Address High
Virtual Address Low
R-Key
DMA Length

FIG. 6

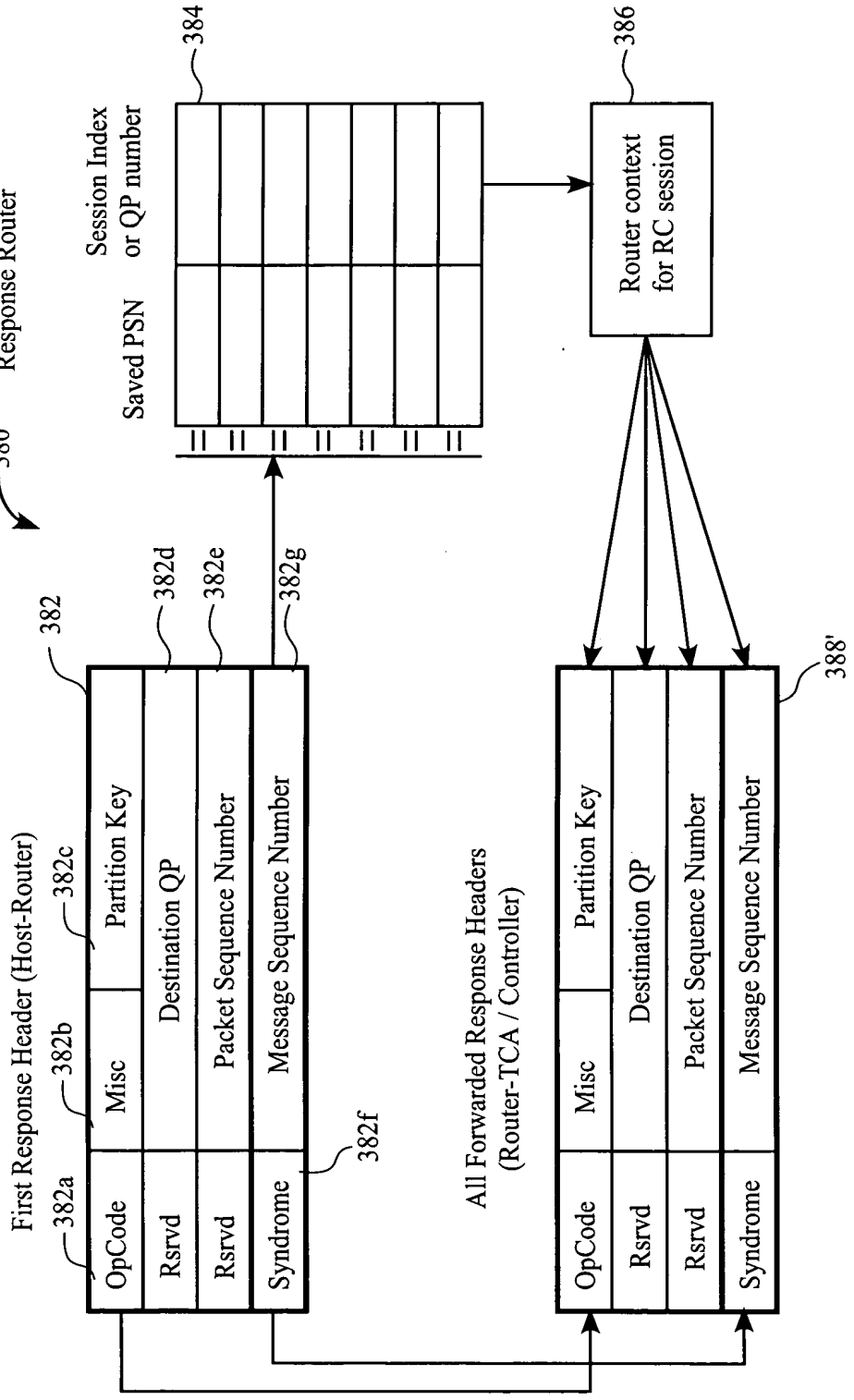
380
Response Router
384
Session Index or QP number
Saved PSN
386
Router context for RC session
382
382d
382e
382g
First Response Header (Host-Router)
382a
382b
382c
OpCode
Rsrvd
Rsrvd
Syndrome
Misc
Destination QP
Packet Sequence Number
Message Sequence Number
Partition Key
382f
All Forwarded Response Headers (Router-TCA / Controller)
388'
OpCode
Rsrvd
Rsrvd
Syndrome
Misc
Destination QP
Packet Sequence Number
Message Sequence Number
Partition Key

FIG. 7

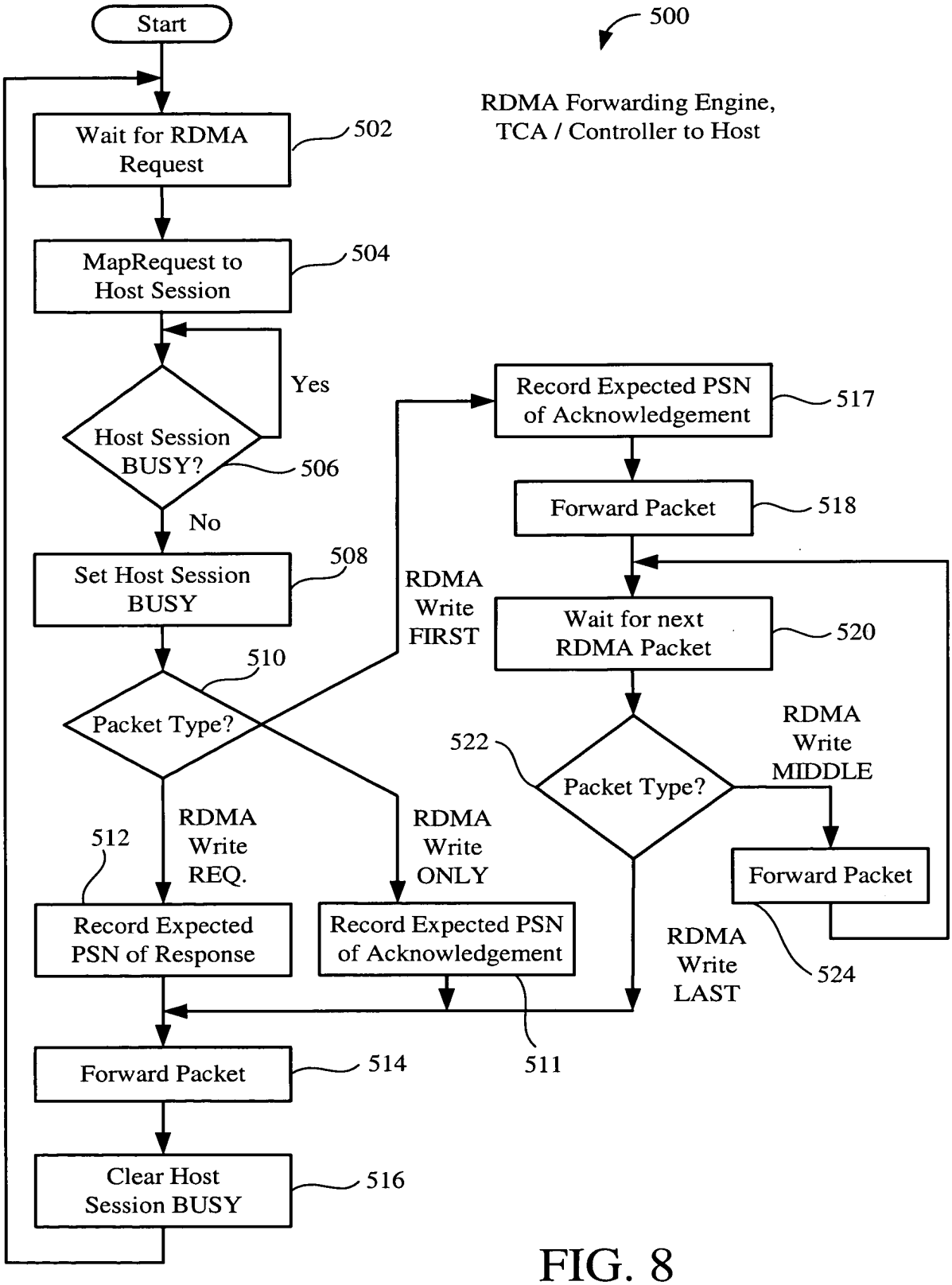
Start
500
RDMA Forwarding Engine,
TCA / Controller to Host
Wait for RDMA Request
502
MapRequest to Host Session
504
Host Session BUSY?
506
Yes
No
Set Host Session BUSY
508
Packet Type?
510
RDMA Write FIRST
RDMA Write REQ.
512
RDMA Write ONLY
Record Expected PSN of Response
Record Expected PSN of Acknowledgement
511
Forward Packet
514
Clear Host Session BUSY
516
Record Expected PSN of Acknowledgement
517
Forward Packet
518
Wait for next RDMA Packet
520
Packet Type?
522
RDMA Write MIDDLE
Forward Packet
524
RDMA Write LAST

FIG. 8

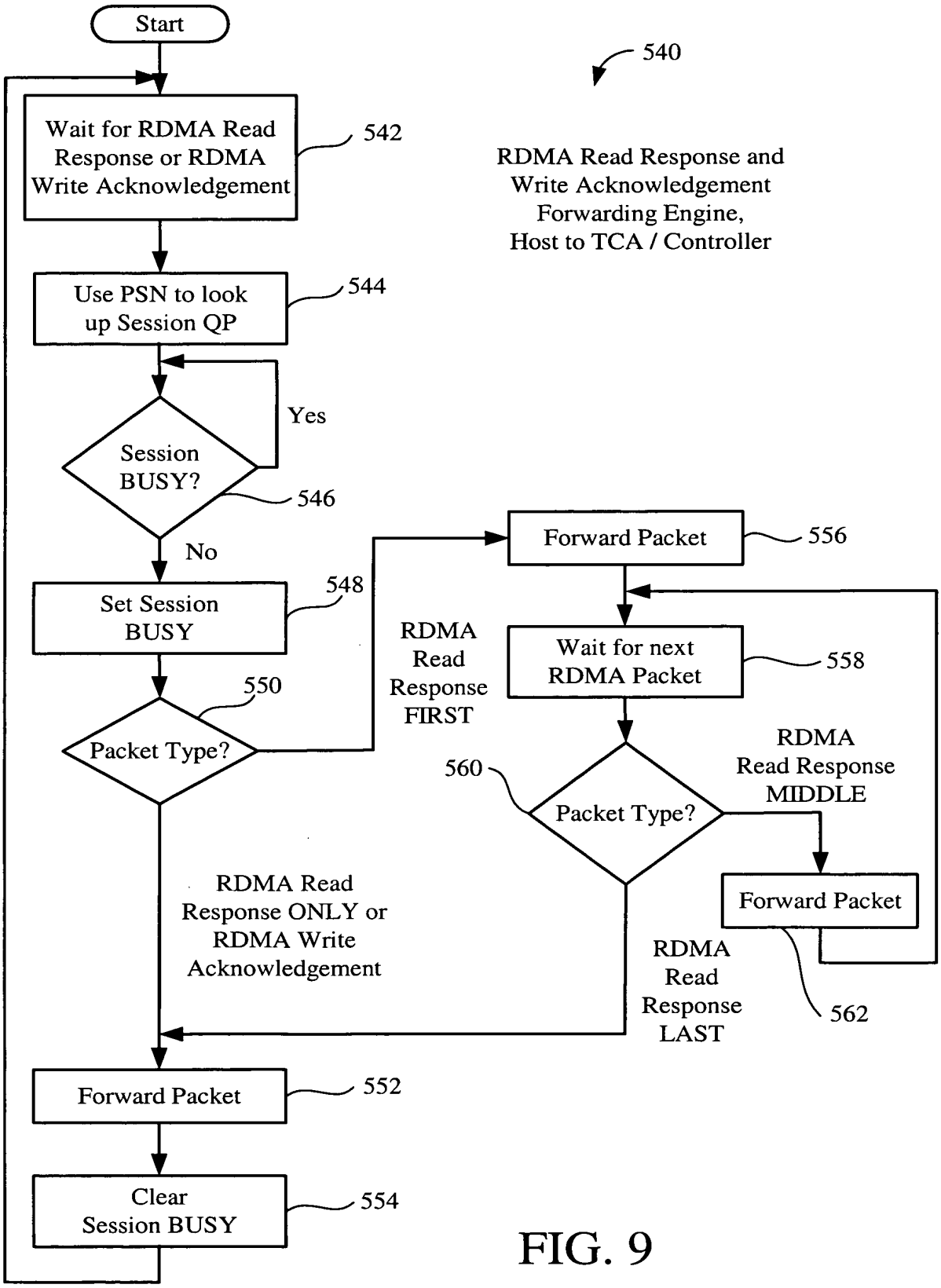
Start
540
Wait for RDMA Read Response or RDMA Write Acknowledgement
542
RDMA Read Response and Write Acknowledgement Forwarding Engine, Host to TCA / Controller
Use PSN to look up Session QP
544
Session BUSY?
Yes
546
No
Set Session BUSY
548
Packet Type?
550
RDMA Read Response ONLY or RDMA Write Acknowledgement
Forward Packet
552
Clear Session BUSY
554
RDMA Read Response FIRST
Forward Packet
556
Wait for next RDMA Packet
558
Packet Type?
560
RDMA Read Response MIDDLE
Forward Packet
562
RDMA Read Response LAST

FIG. 9

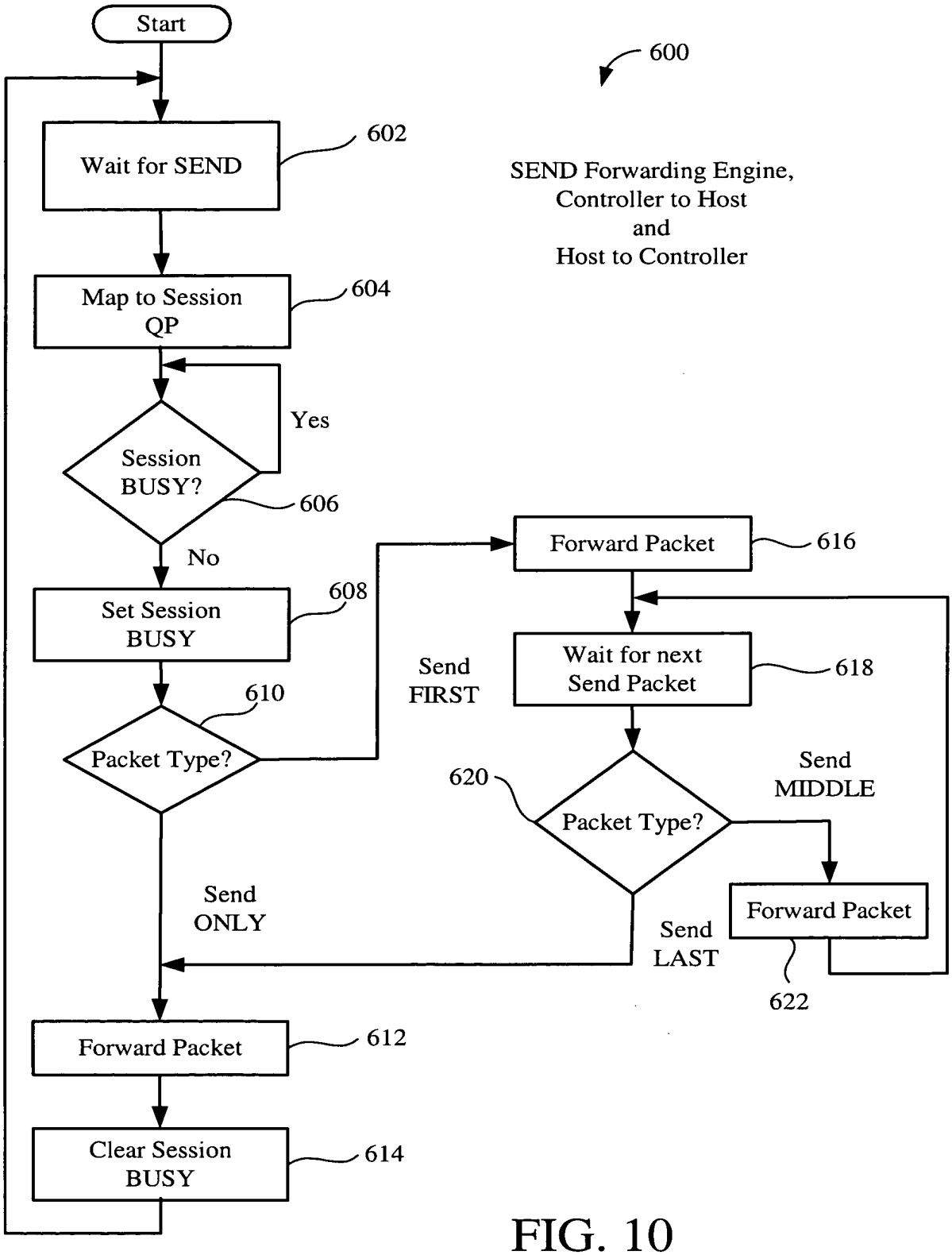
Start
600
Wait for SEND
602
SEND Forwarding Engine,
Controller to Host
and
Host to Controller
Map to Session
QP
604
Session
BUSY?
Yes
606
No
Set Session
BUSY
608
Packet Type?
610
Send
FIRST
Forward Packet
616
Wait for next
Send Packet
618
620
Packet Type?
Send
MIDDLE
Send
ONLY
Send
LAST
Forward Packet
622
Forward Packet
612
Clear Session
BUSY
614

FIG. 10

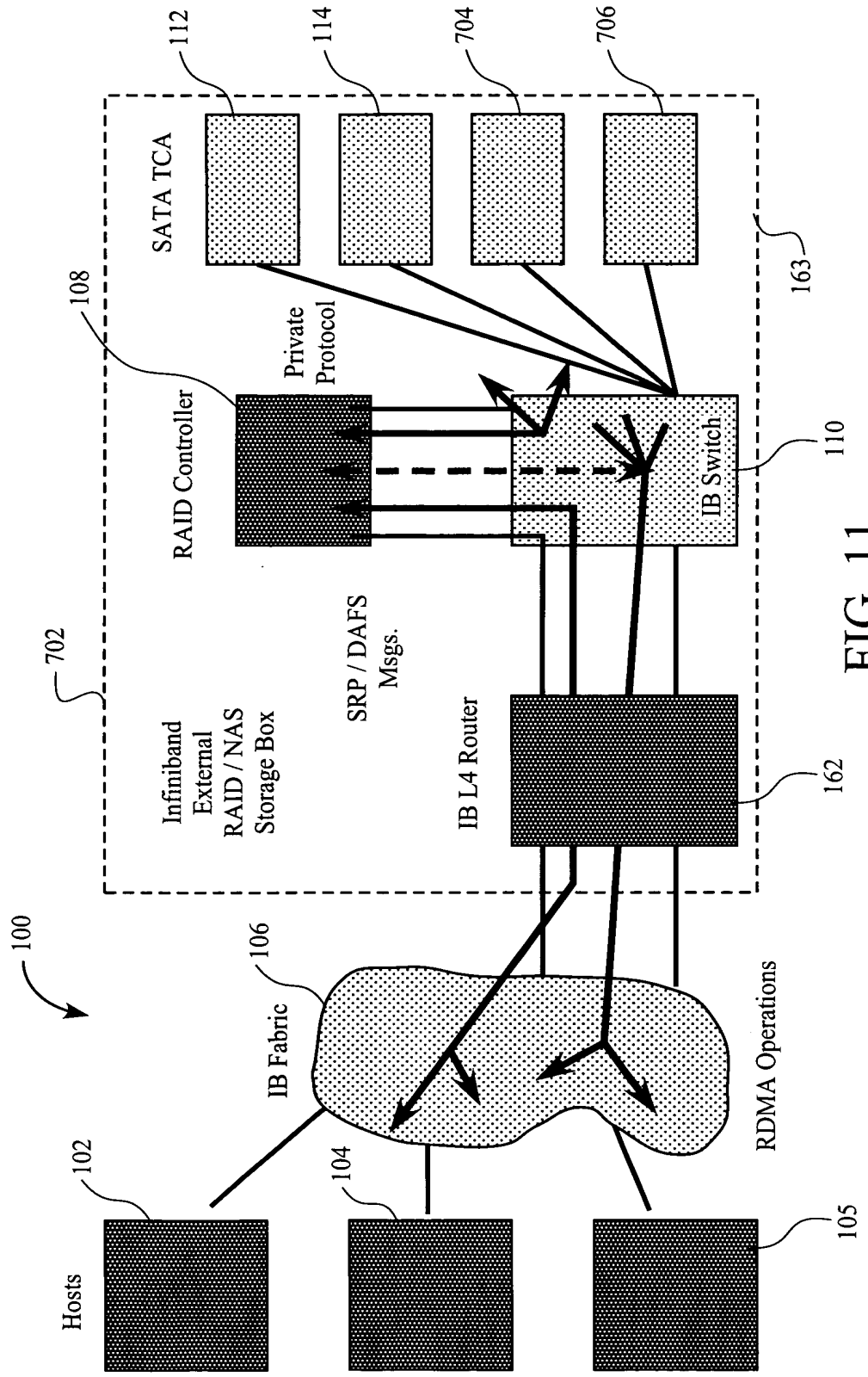
100
Hosts
102
104
105
IB Fabric
106
RDMA Operations
Infiniband External RAID / NAS Storage Box
702
SRP / DAFS Msgs.
IB L4 Router
162
RAID Controller
108
Private Protocol
IB Switch
110
SATA TCA
112
114
704
706
163

FIG. 11

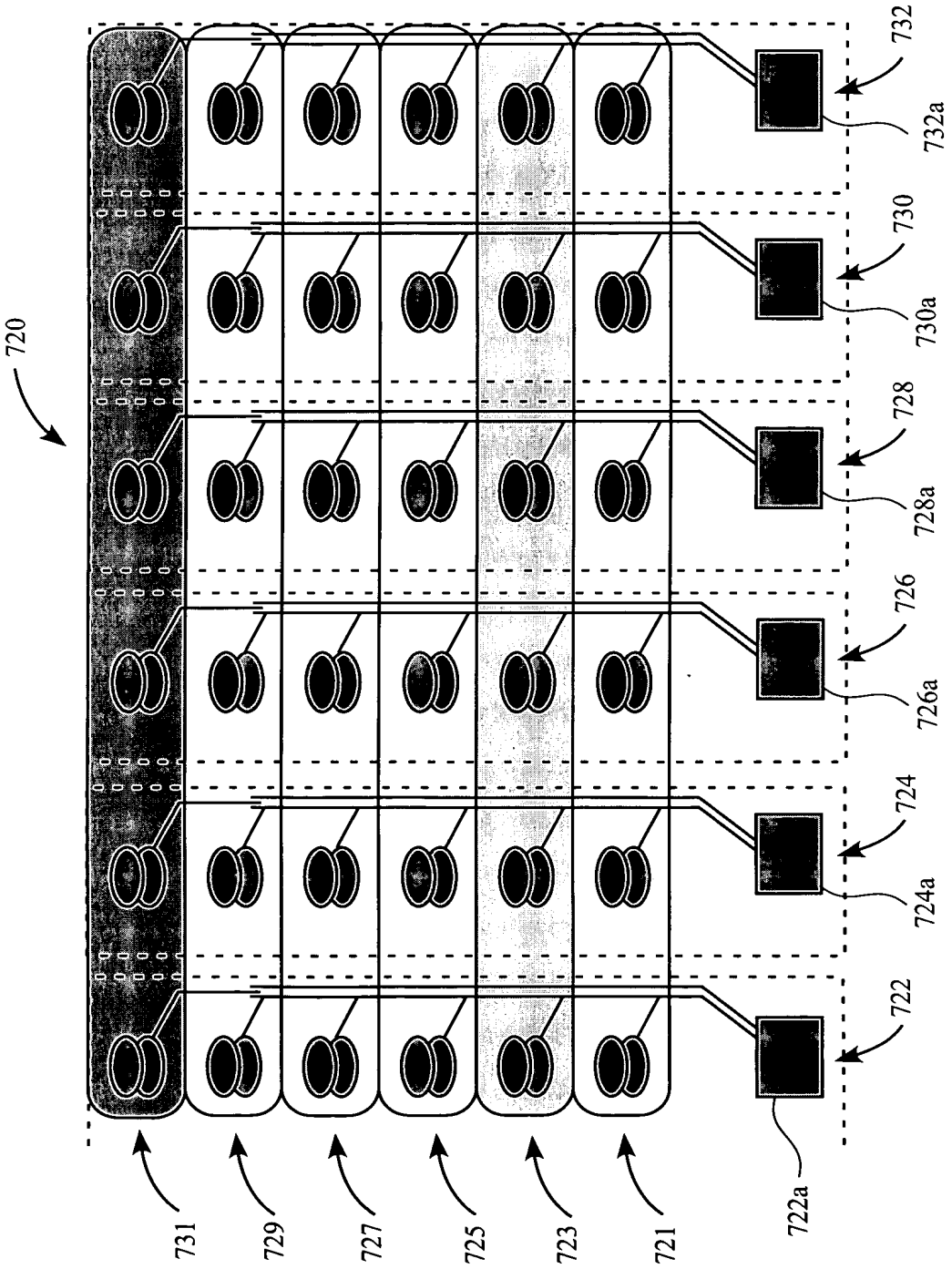
720
732
732a
730
730a
728
728a
726
726a
724
724a
722
722a
731
729
727
725
723
721

FIG. 12

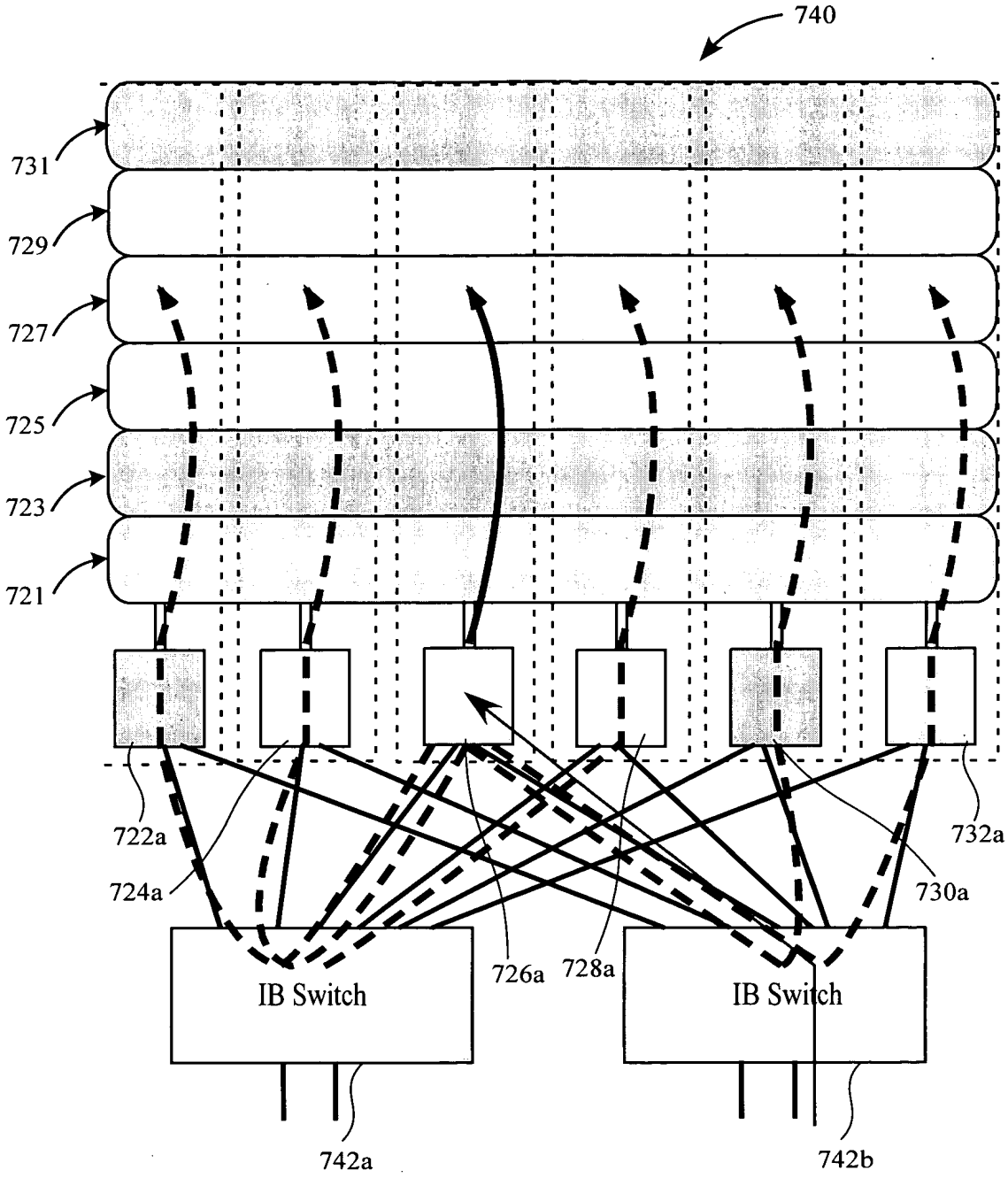
740
731
729
727
725
723
721
722a
724a
726a
728a
730a
732a
IB Switch
IB Switch
742a
742b

FIG. 13

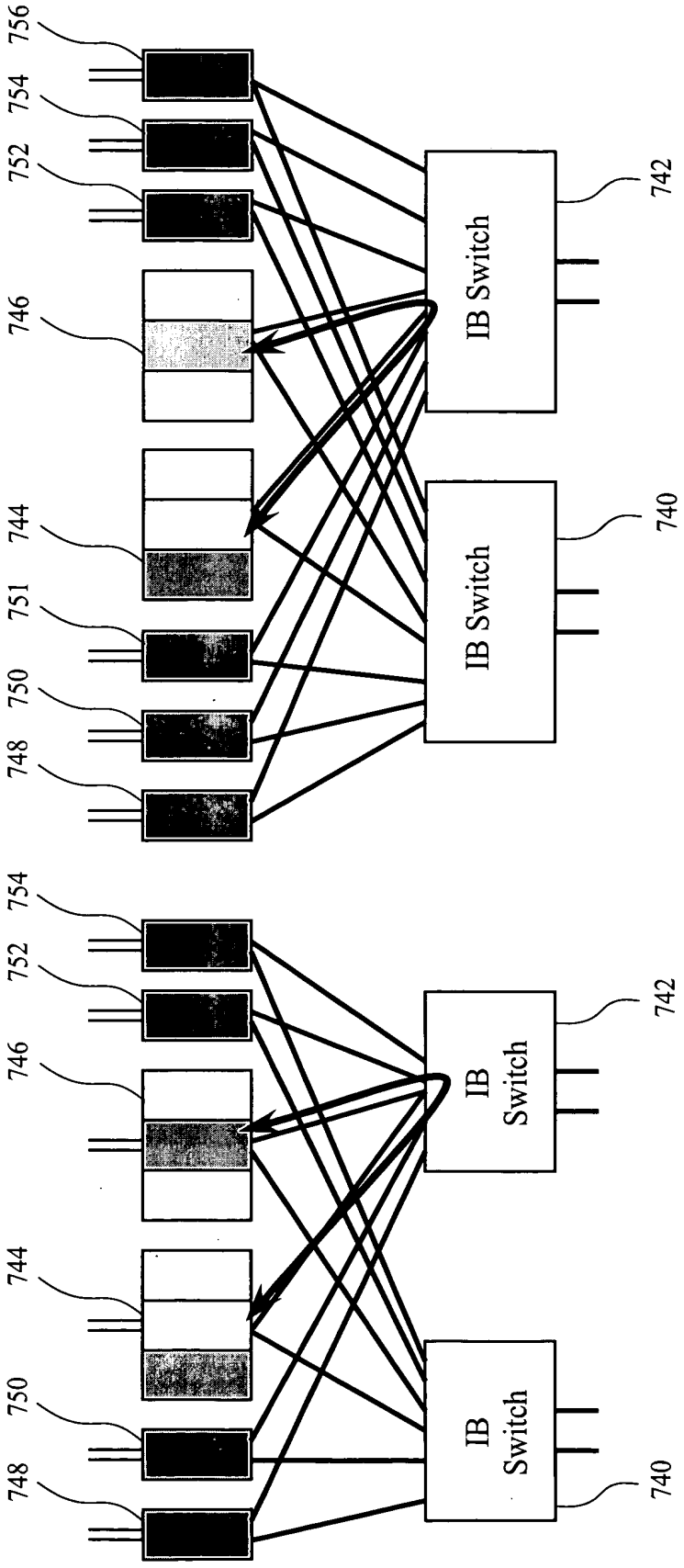

FIG. 14B

FIG. 14A

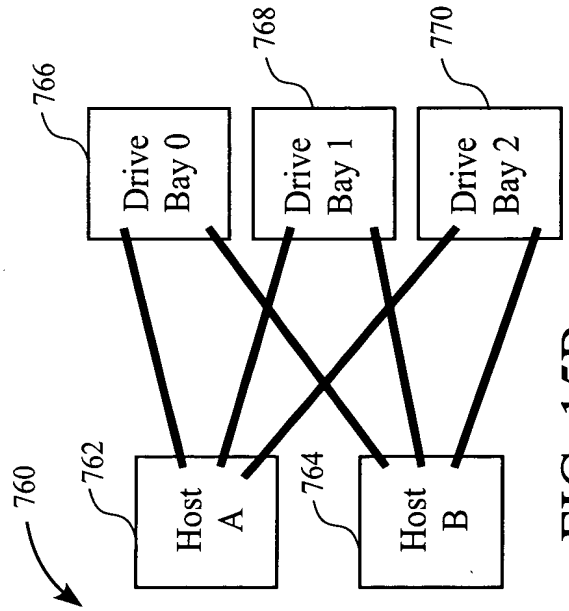

FIG. 15B

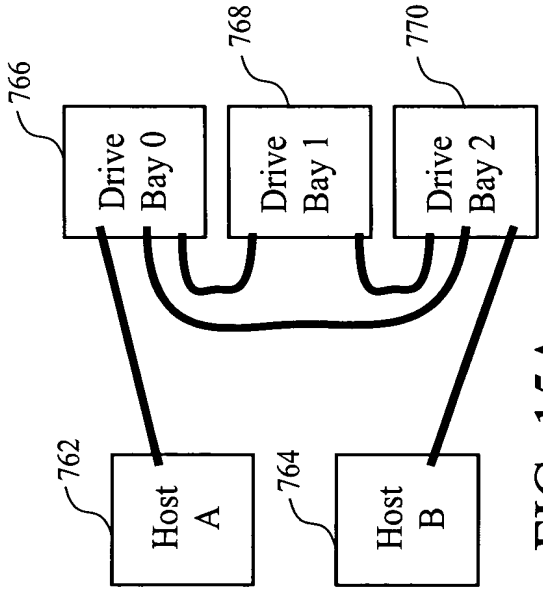

FIG. 15A

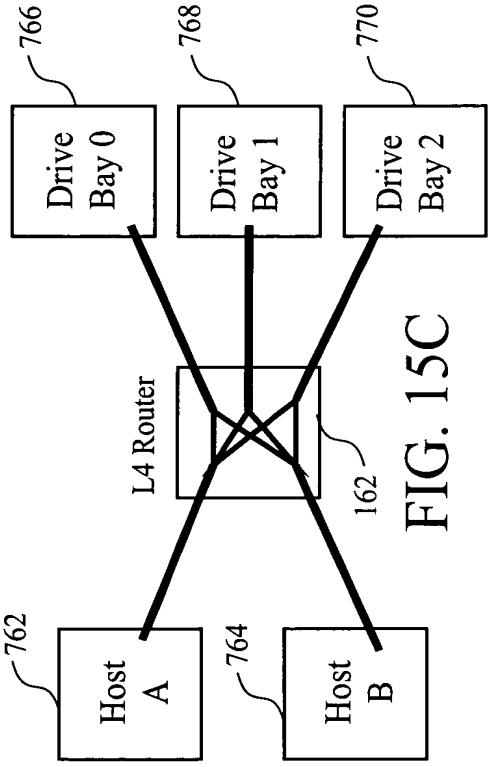

FIG. 15C

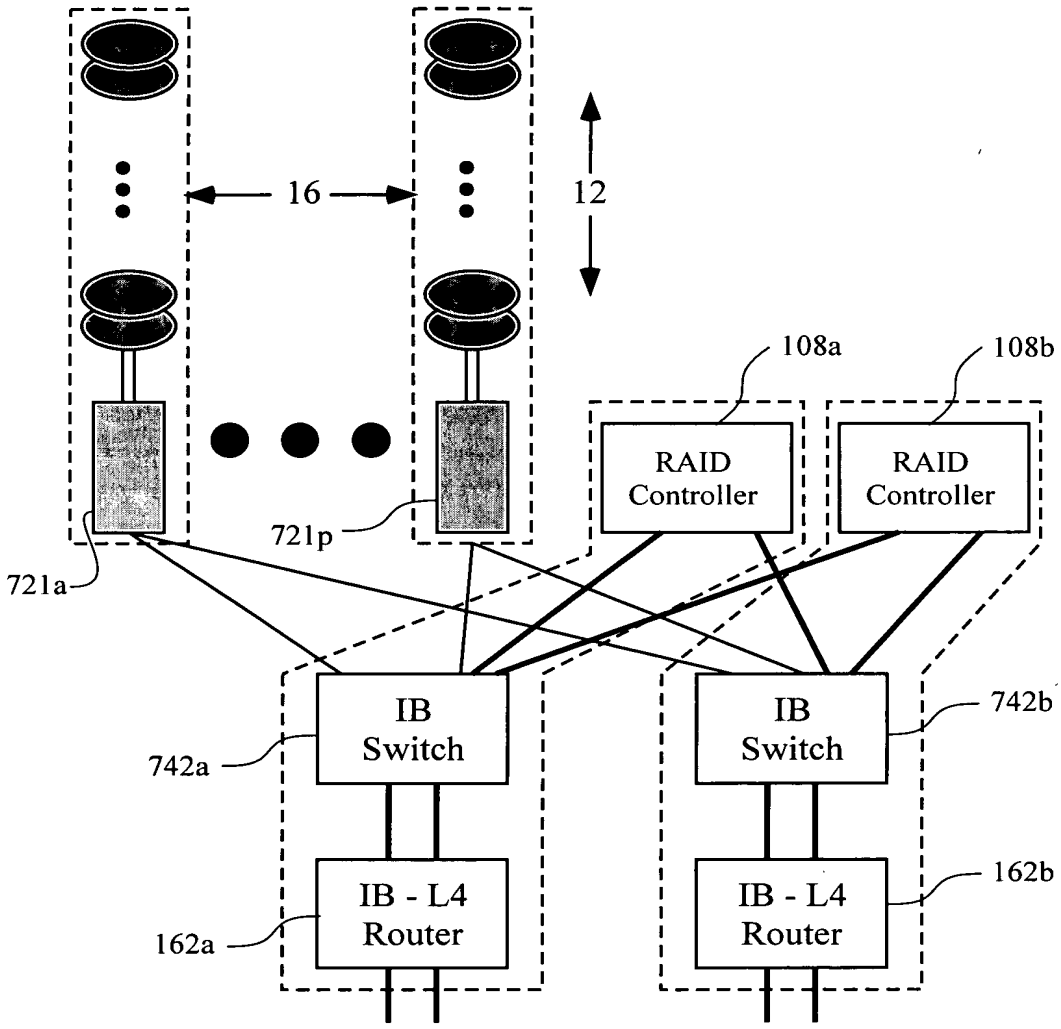
16
12
108a
108b
RAID Controller
RAID Controller
721p
721a
IB Switch
IB Switch
742a
742b
IB - L4 Router
IB - L4 Router
162a
162b

FIG. 16

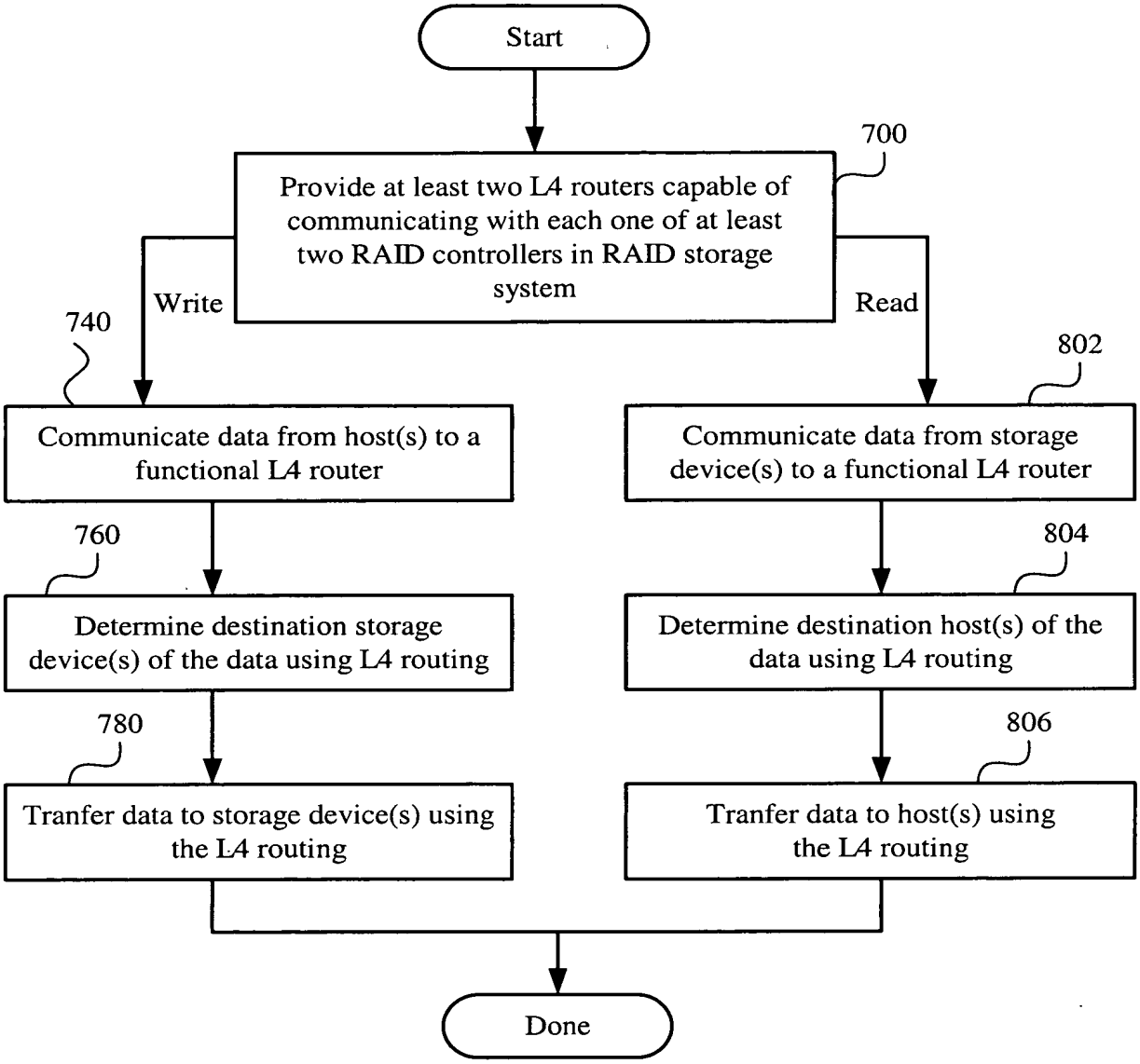
Start
700
Provide at least two L4 routers capable of communicating with each one of at least two RAID controllers in RAID storage system
Write
Read
740
802
Communicate data from host(s) to a functional L4 router
Communicate data from storage device(s) to a functional L4 router
760
804
Determine destination storage device(s) of the data using L4 routing
Determine destination host(s) of the data using L4 routing
780
806
Tranfer data to storage device(s) using the L4 routing
Tranfer data to host(s) using the L4 routing
Done

FIG. 17